REMARKS/ARGUMENTS

Claims 1-22 are pending. Claims1, 2, 4, 8, 9, 14-18, 21 and 22 are amended to correct clerical and typographical errors.

Claims 1-19 and 21-22 are rejected under 35 U.S.C. 102(a) as being anticipated by Brabec et al (NPL: Practical Shadow Mapping); and claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brabec et al. (NPL: Practical Shadow Mapping) in view of Corbetta (US 6,903,741). Applicant submits that all of the claims currently pending in this application are patentably distinguishable over the cited references for the following reasons, and reconsideration and allowance of this application are respectfully requested.

Claim 1 includes, among other limitations, "generating a trapezoid to approximate an area, E, within the eye's frustum in a post-perspective space of a light, L," and "applying a trapezoidal transformation to objects within the trapezoid into a trapezoidal space for computing a shadow map." Brabec does not teach the above limitations.

The Examiner cited to page 8 lines 2-5 and page 3 lines 24-26 of Brabec as disclosing the above limitations. Applicant respectfully disagrees. The cited page 8 lines 2-5 of Brabec describe "the resulting minimum area enclosing rectangle are drawn as they are located in the non-optimized shadow map." (Underlining added.). Accordingly, it is clear that in Brabec, a minimum area enclosing rectangle is used for shadow generation. Also, see "Axis aligned bounding rectangle" and "Optimal bounding rectangle" on page 6 of Brabec. (Underlining added.).

Indeed, in Brabec, a rotating calipers algorithm is used for computing a minimum area enclosing rectangle. It is explicitly described at Brabec page 7 lines 6-8 that "the rotating calipers algorithm rotates two sets of parallel lines (calipers) around the polygon and incrementally updates the extreme values, thus requiring only linear time to find the optimal bounding rectangle". One skilled in the art would readily realize that using two sets of parallel lines would always result in rectangles. Moreover, Brabec does not disclose or suggest using

any other boundary forms other than rectangles. There is also no disclosure or suggestion of any modifications to the rectangle shape of Brabec.

Similarly, Applicant respectfully submits that nowhere in Brabec is there any disclosure or suggestion of using a trapezoid for approximating an area, or any trapezoidal transformation of objects within a trapezoid into a trapezoidal space, for computing a shadow map.

Furthermore, the rectangle techniques in Brabec give rise to a number of problems that have been discussed in detail and solved, advantageously, by example embodiments implementing the above features of claim 1. For example, for one problem, Applicant respectfully submits that Brabec does not handle smooth transitions of shadows that is advantageously taken care of by example embodiments of the present application. With reference to Figure 2(a) of the present application, using a rectangular bounding box 204 (as with Brabec) results in a significantly poorer shadow 212 (after transition) as compared to shadow 210. In contrast, with reference to Figure 2(b) of the present application, an example embodiment using a trapezoid results in a shadow 220 (after transition) that is of acceptable quality as compared to shadow 218. Refer also to the text description e.g. at [0084] and [0090] of the present application.

As a further example, for another problem, Applicant respectfully submits that Brabec results in a problem of wastage that is advantageously avoided/minimized by example embodiments of the present application. Please refer to [0088] to [0089] and [0099] to [0101], and Figure 3 of the present application. The box space 310 arising from use of a rectangular bounding box 308 (as with Brabec) results in wastage of shadow map space, as compared to the box space 304 arising from use of a trapezoid 306 in an example embodiment of the present application.

Accordingly, the above mentioned exemplary embodiments can solve the above two problems of Brabec by generating a trapezoid to "squeeze" as much as possible available shadow map space (refer to 304 in Figure 3), while maintaining coherent transition of trapezoids from one time frame to a next time frame (refer to Figure 2(b)).

As a result, claim 1 is not anticipated by Brabec and therefore is patentable over the cited references.

Independent **claims 21 and 22** include similar limitation, therefore, they are also patentable over the cited references.

Dependent **claim 2** is directed at generating the top and base lines of the trapezoid defined in claim 1. In addition to Brabec not disclosing or suggesting generating a trapezoid, Brabec does not disclose or suggest "computing a centre line 1, which pass through the near and far planes of E". The Examiner cites to homogenous P at page 3 lines 27-28 of Brabec as teaching the above feature. Applicant respectfully disagrees. Brabec states that P is a homogenous point, not a line. That is, Brabec describes at this portion "Instead of transforming all components of a homogeneous point $P=(x_e,y_e,z_e,w_e)$ by the perspective transformation matrix, e.g. $(x,y,z,w)=Light_{proj}.P$, we replace the z component by a new value $z'=z_l*w$." Applicant is unable to find in Brabec any disclosure or suggestion of a centre line passing through near and far planes. It is also noted that the Examiner later uses P to object to a point P_L in claim 4. Furthermore, the Examiner has constructed "near and far planes" mentioned in Brabec at page 4 line 2 as the lines l_t and l_b defined in claim 2. Applicant respectfully disagrees. Clearly, planes cannot be reasonably equated to lines. In addition, there is no disclosure or suggestion of any lines in Brabec that touches a boundary of a convex hull, as defined for the lines l_t and l_b in claim 2.

Accordingly, claim 2 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 3** recites, inter alia, "a smallest box bounding the far plane is defined as the trapezoid." Again, the Examiner cites to page 7 lines 6-8 of Brabec as disclosing the above limitation. Applicant respectfully disagrees. The cited portion of Brabec merely describes "The rotating calipers algorithm rotates two sets of parallel lines (calipers) around the polygon and incrementally updates extreme values, thus requiring only linear time to find the optimal bounding rectangle." There is no disclosure or suggestion of a far plane at this cited portion of

Brabec. There is also no disclosure or suggestion of using a smallest box bounding a far plane, notwithstanding Brabec not disclosing or suggesting a trapezoid.

Therefore, claim 3 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 4** includes the additional limitation, inter alia, of "constructing two side lines of the trapezoid each passing through q, wherein each sideline touches the 2D convex hull of E on respective sides of I". Brabec does not teach this limitation. The Examiner has referred to a bounding rectangle at page 6 lines 1-5 under the section Optimal bounding rectangle of Brabec as anticipating the above feature. Applicant respectfully disagrees. The cited portion of Brabec merely describes "A better solution for adjusting the view of the light source is to compute the optimal bounding rectangle that encloses all visible pixels. This can be realized by using a method known as the rotating calipers algorithm [9,6] which is capable of computing the minimum area enclosing rectangle in linear time. We start by computing the two dimensional convex hull of all visible points using the monotone chain algorithm proposed." However, Applicant fails to find any disclosure or suggestion of two side lines passing through a point and that each sideline touches a convex hull, and further, these side lines are side lines of a trapezoid, in Brabec.

Thus, claim 4 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 6** recites, inter alia, an iterative process. The Examiner cites to page 3 lines 27-31 of Brabec, i.e. the linear depth value z1, as teaching the above feature. Applicant respectfully disagrees. The cited text describes: "Instead of transforming all components of a homogeneous point $P=(x_e,y_e,z_e,w_e)$ by the perspective transformation matrix, e.g. $(x,y,z,w)=Light_{proj}.P$, we replace the z component by a new value $z'=z_l*w$. The linear depth value $z_l \in [0;1]$ corresponds to the eye space value z_e mapped according to the light source near and far plane". However, nowhere in this portion of Brabec is there any disclosure or suggestion of determining a desired point based on an iterative process. There is also no disclosure or

suggestion of any iterative process that minimizes wastage. Examples of minimizing wastage can be found at e.g. [0099] to [0107] of the present application.

Accordingly, claim 6 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 8** includes the additional limitation of "the iterative process is pre-computed and the results are stored in a table for direct reference." The Examiner has referred to page 5 lines 30-33 of Brabec, i.e. this way all vertices are forced to lie between ..., as disclosing the above feature. Applicant respectfully disagrees. This cited portion describes "This way all vertices are forced to lie between the valid [0;1] z range. The z values passed as texture coordinates for texture unit 0 are still the linear z_l's. After the depth replace step we then restore valid z coordinates used for depth testing." Applicant respectfully submits that nowhere in this portion of Brabec is there any disclosure or suggestion of pre-computing and/or any table for storing results for direct reference.

Therefore, claim 8 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 9** includes the additional limitations of "determining an intersection I, between the light source's frustum and the eye's frustum; computing the centre point e of the vertices of I; defining a centre line l_n passing through the position of the eye and e, for generating the trapezoid." The Examiner refers to page 6 lines 1-5 under the section Optimal bounding rectangle of Brabec, i.e. generating the optimal bounding rectangle, as anticipating the above feature. Applicant respectfully disagrees. This cited portion of Brabec describes "A better solution for adjusting the view of the light source is to compute the optimal bounding rectangle that encloses all visible pixels. This can be realized by using a method known as the rotating calipers algorithm [9,6] which is capable of computing the minimum area enclosing rectangle in linear time. We start by computing the two dimensional convex hull of all visible points using the monotone chain algorithm proposed." Applicant respectfully submits that nowhere in this

portion of Brabec, which describes a rotating calipers algorithm, is there any disclosure or suggestion of a centre line such as defined in claim 9.

As a result, claim 9 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

Dependent **claim 13** recites, inter alia, "z value is maintained at the value in the post perspective space of the light". The Examiner has referred to the section on optimal bounding rectangle of Brabec as anticipating the above feature. Applicant disagrees. Applicant respectfully submits that nowhere in this portion of Brabec is there any disclosure or suggestion of z co-ordinates. Indeed, the generation of the rectangle in Brabec is directed at x and y values only.

Regarding rejection of **claim 20** over Brabec in view of Corbetta, Corbetta does not teach or suggest at least "generating a trapezoid to approximate an area E, within the eye's frustum in the post-perspective space of the light, L" and "applying a trapezoidal transformation to objects within the trapezoid into a trapezoidal space for computing a shadow map", as recited in claim 20 (dependent on claim 1). Thus, Corbetta does not cure the mentioned deficiencies of Brabec.

Accordingly, claim 20 is also patentable in view of the cited references, as being dependent from the allowable independent claim 1, and for the additional limitations it includes therein.

In short, dependent claims 2-20 are dependent from allowable independent claim 1, and therefore include all the limitations of the allowable claim 1 and additional limitations therein. Accordingly, these claims are also allowable over the cited references, as being dependent from the allowable independent claim 1,and for the additional limitations they include therein.

In view of the foregoing amendments and remarks, it is respectfully submitted that this application is now in condition for allowance, and accordingly, reconsideration and allowance are respectfully requested.

Respectfully submitted,
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